Modelling Temporal Diffusion of PV Microgeneration Systems in Rural Western Kenya

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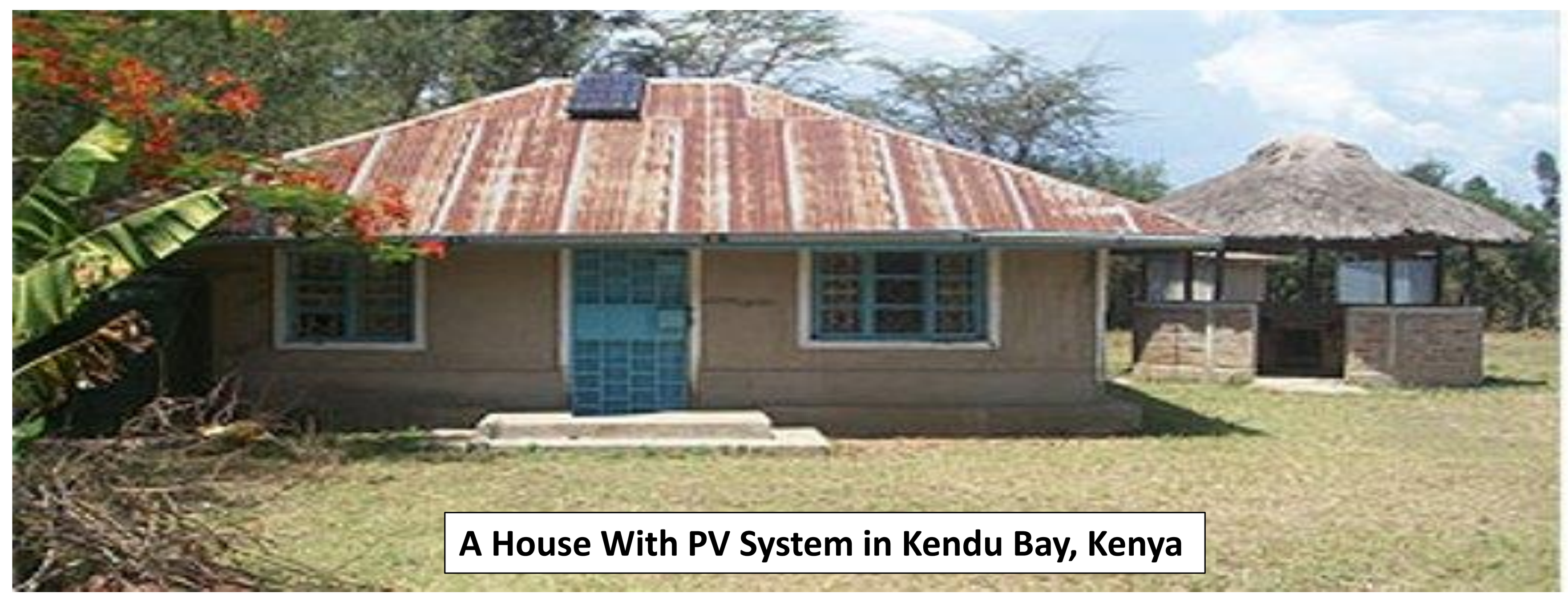
Introduction

Development of electricity delivery infrastructures are path-dependent with each development decision and step affecting subsequent steps and the final outcome. The main factors that influence choices of technology used in rural electrification are resource availability, cost, demand, social acceptance, and government policies (subsidies). An agent-based model (ABM) is developed in Netlogo and used to simulated how socio-economic factors affect diffusion of PV microgeneration systems in a rural developing community. Survey data from Kendu Bay, Kenya, are used to build the model.



A House With PV System in Kendu Bay, Kenya

Methodology

Idea to install PV (PV_{Idea}) is developed given factors such as cost, subsidies, and neighbourhood influence as,

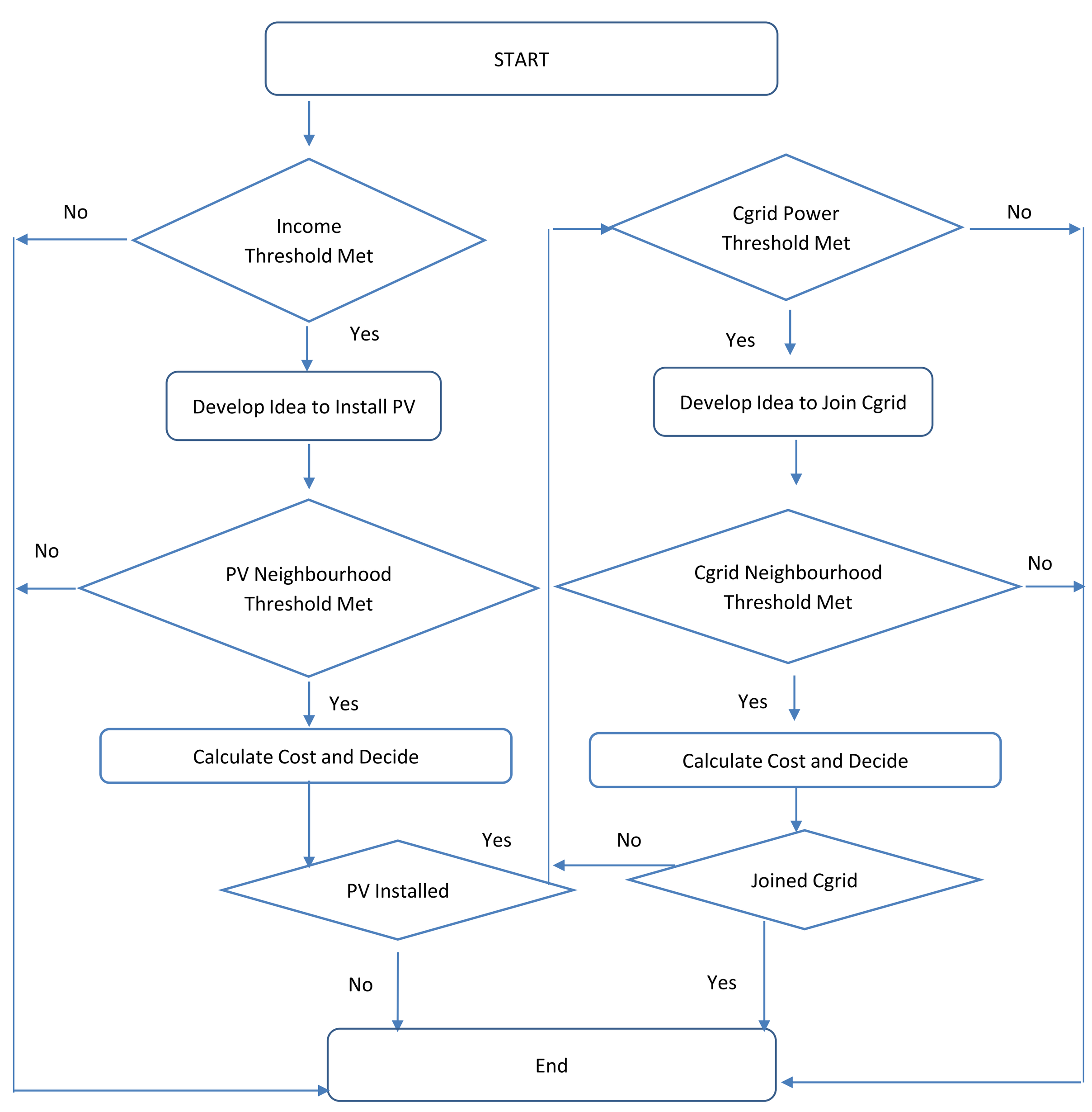
$$PV_{Idea} = \sum_{i=1}^{n} W_i F_i,$$

where n is the total number of factors and W_i is the weight associated with each factor F_i .

Decision to install PV returns true if

$$\frac{H_{PV-SR}}{H_{Total-SR}} \times 100\% > NT,$$

where H_{PV-SR} is the number of houses with PV within a given sensing radius (SR) or neighbourhood, $H_{Total-SR}$ is the total number of houses within the same sensing radius, and NT is neighbourhood threshold. After a cost analysis, PV is installed if it is cheaper than other available electrification options



Algorithm of Simulation Sequences

Develop idea to connected to communal a grid ($Cgrid_{Idea}$) given factors such as cost, subsidies, and neighbourhood influence.

$$Cgrid_{Idea} = \sum_{i=1}^{n} W_{ig} F_{ig},$$

where n is the total number of factors and W_{ig} is the weight associated with each factor F_{ig} .

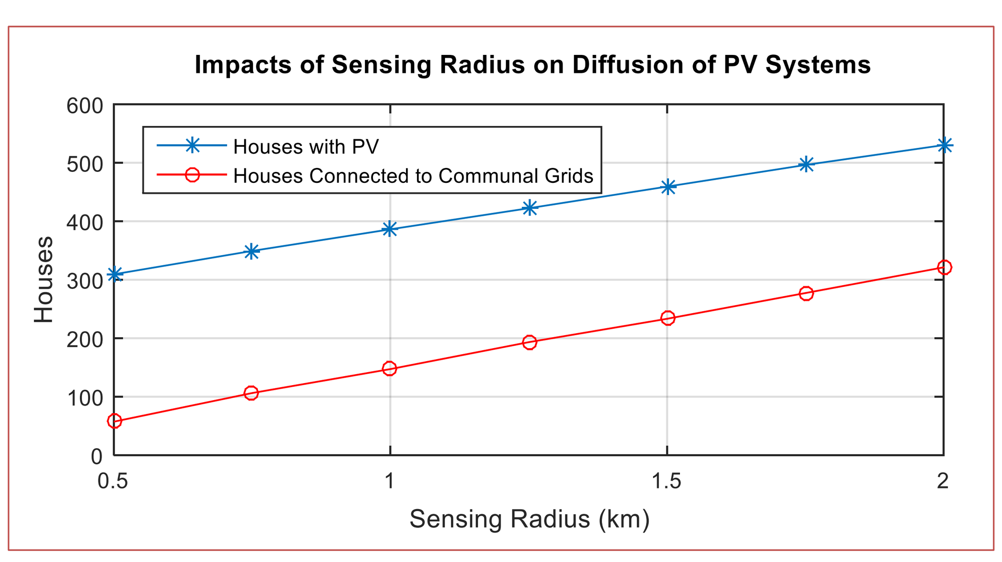
Decision to connect to communal grid returns true if

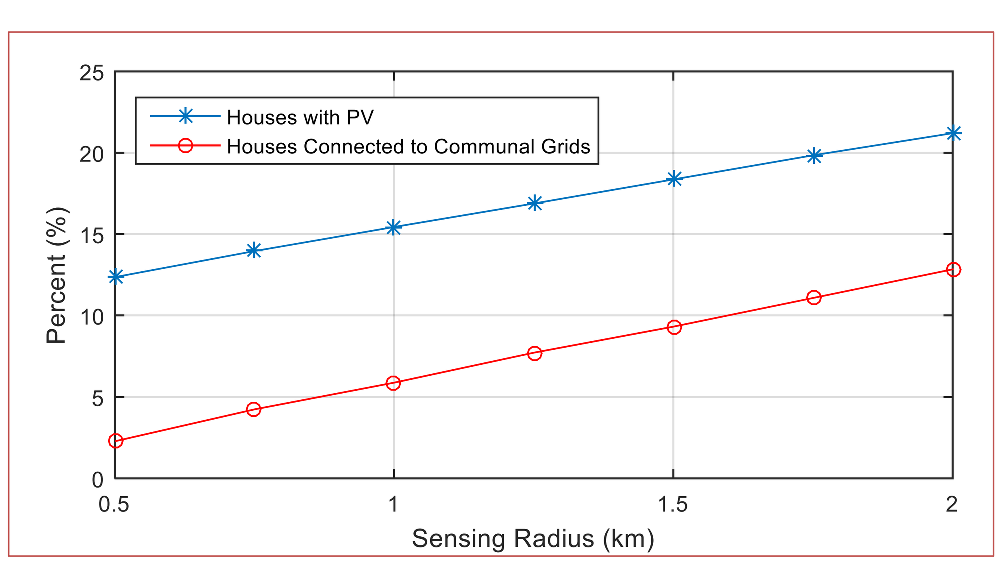
$$\frac{H_{CGRID-SR}}{H_{Total-SR}} \times 100 > T_{CGRID-SR},$$

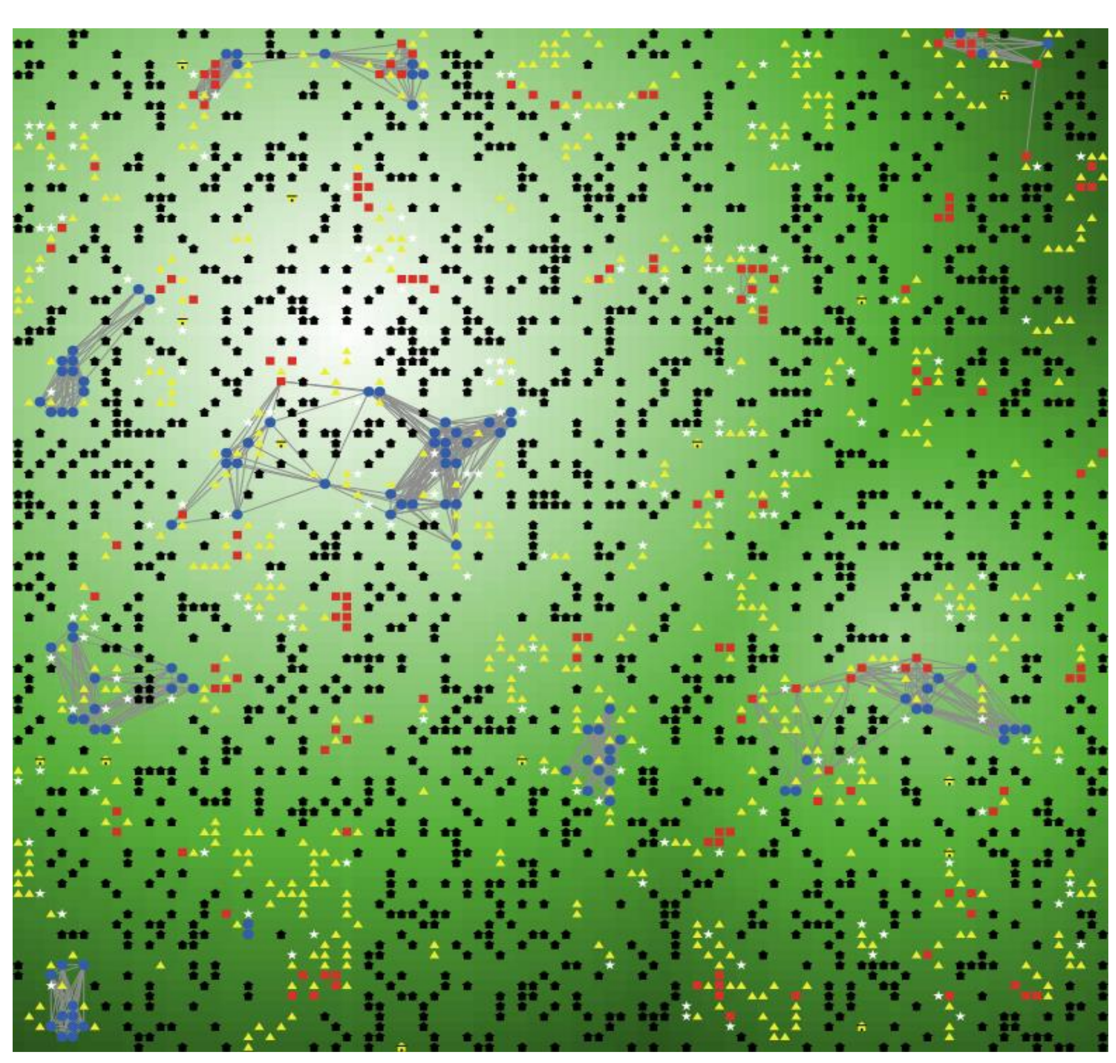
where $H_{CGRID-SR}$ is the number of houses with PV within a given grid sensing radius that meet the power-threshold, $H_{Total-SR}$ is the total number of houses within the same sensing radius, and $T_{CGRID-SR}$ is the communal grid neighbourhood threshold.

Results

Houses installing PV, and correspondingly forming or joining communal grids increase with increasing neighbourhood influence as shown below [2].



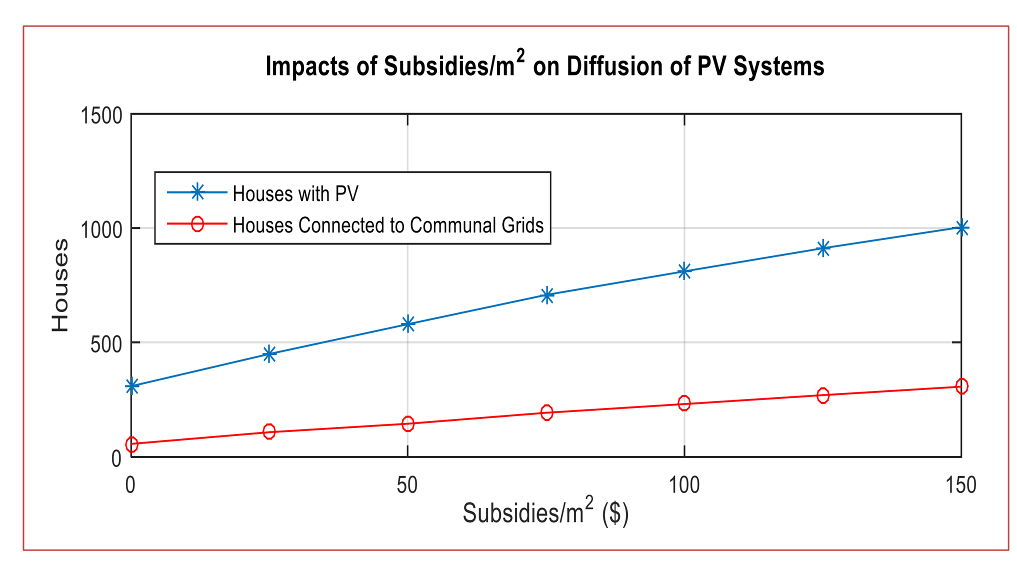


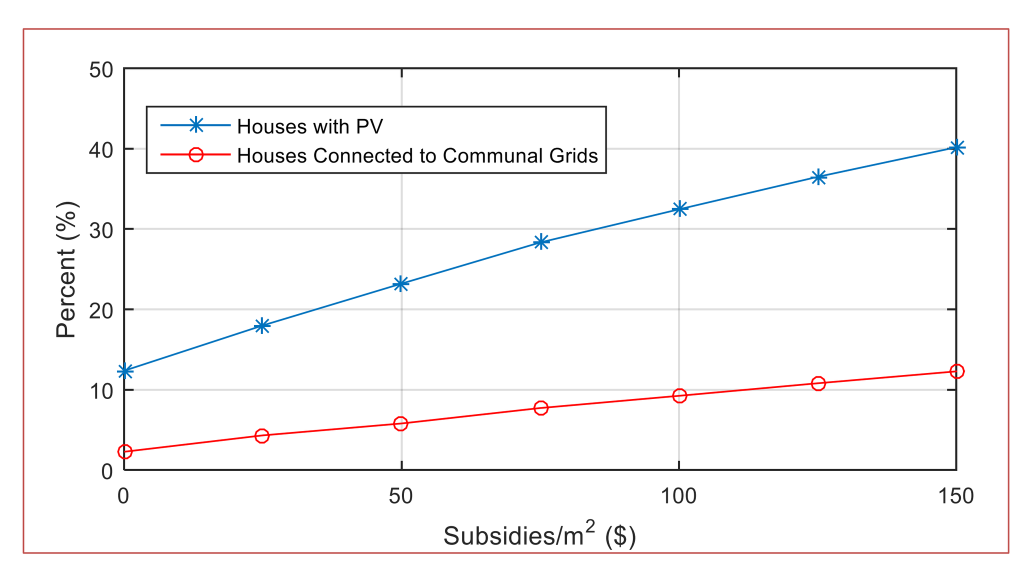


View of Landscape After Simulations:

Black houses are those without PV, white (star) houses are thinking of installing PV, yellow (triangle) houses have PV, red (square) houses are thinking joining of communal grids, blue (circle) connected to communal grids through grey links (grid lines).

Houses installing PV, and correspondingly forming or joining communal grids increase with increasing subsidies as shown in the figure below [2].





Conclusion: Introduction of favourable government policies in forms of subsidies, coupled with increasing social acceptance would lead to increased PV installations, and subsequent communal grids connections, in a given rural developing community.

References:

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[2] Opiyo, N., Crook, R., Taylor, P. G., *A Survey Informed PV-Based Cost-Effective Electrification Options for Rural Sub-Saharan Africa*, Energy Policy **91**: 1-11, 2016

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